



General

Guideline Title

Clinical practice guidelines for sustained neuromuscular blockade in the adult critically ill patient.

Bibliographic Source(s)

Murray MJ, DeBlock H, Erstad B, Gray A, Jacobi J, Jordan C, McGee W, McManus C, Meade M, Nix S, Patterson A, Sands MK, Pino R, Tescher A, Arbour R, Rochweg B, Murray CF, Mehta S. Clinical practice guidelines for sustained neuromuscular blockade in the adult critically ill patient. Crit Care Med. 2016 Nov;44(11):2079-103. [230 references] [PubMed](#)

Guideline Status

This is the current release of the guideline.

This guideline updates previous versions: Clinical practice guidelines for sustained neuromuscular blockade in the adult critically ill patient. Am J Health Syst Pharm. 2002 Jan 15;59(2):179-95. [78 references]

Neuromuscular Blockade Task Force. Clinical practice guidelines for sustained neuromuscular blockade in the adult critically ill patient. Crit Care Med. 2002;30(1):142-56. [78 references]

This guideline meets NGC's 2013 (revised) inclusion criteria.

NEATS Assessment

National Guideline Clearinghouse (NGC) has assessed this guideline's adherence to standards of trustworthiness, derived from the Institute of Medicine's report [Clinical Practice Guidelines We Can Trust](#).

■■■■■= Poor ■■■■= Fair ■■■■= Good ■■■■= Very Good ■■■■= Excellent

Assessment	Standard of Trustworthiness
YES	Disclosure of Guideline Funding Source
■■■■■	Disclosure and Management of Financial Conflict of Interests

	Guideline Development Group Composition
UNKNOWN	Multidisciplinary Group
YES	Methodologist Involvement
■□□□□	Patient and Public Perspectives
	Use of a Systematic Review of Evidence
■■■■■□	Search Strategy
■■■■■□	Study Selection
■■■■■□	Synthesis of Evidence
	Evidence Foundations for and Rating Strength of Recommendations
■■■■■□	Grading the Quality or Strength of Evidence
■■■■■	Benefits and Harms of Recommendations
■■■■■	Evidence Summary Supporting Recommendations
■■■■■□	Rating the Strength of Recommendations
■■■■■	Specific and Unambiguous Articulation of Recommendations
■■■■□□	External Review
■■□□□□	Updating

Recommendations

Major Recommendations

Definitions of the strength of recommendations (*strong, weak, good practice*) and quality of the evidence (*high, moderate, low, very low*) are provided at the end of the "Major Recommendations" field.

Acute Respiratory Distress Syndrome (ARDS)

I. Among adult patients with ARDS, should a neuromuscular-blocking agent (NMBA) be administered to improve survival?

Recommendation: The Task Force suggests that an NMBA be administered by continuous intravenous (IV) infusion early in the course of ARDS for patients with a partial pressure of oxygen (Pao₂)/fraction of inspired oxygen (Fio₂) less than 150 (*weak recommendation; moderate quality of evidence*; refer to Table 1 in the original guideline document for the evidence profile).

Status Asthmaticus

II. Among adult patients with status asthmaticus who are intubated and mechanically ventilated, is there a role for the administration of an NMBA to improve survival or hypoxemia?

Recommendation: The Task Force suggests against the routine administration of an NMBA to mechanically ventilated patients with status asthmaticus (*weak recommendation, very low quality of evidence*; refer to Table 2 in the original guideline document for the evidence profile).

The Task Force suggests a trial of an NMBA in life-threatening situations associated with profound hypoxemia, respiratory acidosis, or hemodynamic compromise when other measures such as deep sedation fails (*weak recommendation, very low quality of evidence*).

III. Among adult patients with acute brain injury and elevated intracranial pressure (ICP), does the administration of an NMBA improve survival?

Recommendation: The Task Force makes no recommendations as to whether neuromuscular blockade is beneficial or harmful when used in patients with acute brain injury and raised ICP (*insufficient evidence*).

Therapeutic Hypothermia

IV. For patients undergoing therapeutic hypothermia/targeted temperature management (e.g., to improve neurologic outcome following cardiac arrest), should neuromuscular blockade be used to improve survival or secondary outcomes?

Recommendation: The Task Force makes no recommendation on the routine use of NMBAs for patients undergoing therapeutic hypothermia following cardiac arrest (*insufficient evidence*).

The Task Force suggests that NMBAs can be used to manage overt shivering in therapeutic hypothermia (*weak recommendation, very low quality of evidence*).

V. If neuromuscular blockade is used during therapeutic hypothermia, should peripheral nerve stimulation (PNS) be used to monitor the degree of block?

Recommendation: The Task Force makes no recommendation on the use of PNS to monitor degree of block in patients undergoing therapeutic hypothermia (*insufficient evidence*).

The Task Force recommends that, if PNS is used, it be done in conjunction with assessment of other clinical findings (e.g., triggering of the ventilator and degree of shivering) to assess the degree of neuromuscular blockade in patients undergoing therapeutic hypothermia (*good practice statement*).

VI. In patients undergoing therapeutic hypothermia, should a protocol that includes guidance on NMBA administration be used?

Recommendation: The Task Force recommends the use of a protocol that includes guidance on NMBA administration in patients undergoing therapeutic hypothermia (*good practice statement*).

Hemodynamic Indications

VII. In patients who are mechanically ventilated, does neuromuscular blockade improve the accuracy of intravascular-volume assessment (i.e., respiratory-induced variations in hemodynamic indexes)?

Recommendation: The Task Force makes no recommendation on the use of neuromuscular blockade to improve the accuracy of intravascular-volume assessment in mechanically ventilated patients (*insufficient evidence*).

Sedation and Analgesia

VIII. Do patients receiving NMBAs require sedation and analgesia?

Recommendation: The Task Force recommends that optimal clinical practice requires administering analgesic and sedative drugs prior to and during neuromuscular blockade, with the goal of achieving deep sedation (*good practice statement*).

IX. In critically ill patients on continuous infusions of NMBAs, do electroencephalogram-derived parameters (e.g., Bispectral Index [BIS], E-entropy, Cerebral State Index, and Patient State Index) improve sedation assessment?

Recommendation: The Task Force makes no recommendation concerning the use of electroencephalogram-derived parameters as a measure of sedation during continuous administration of NMBAs (*insufficient evidence*).

General Care and Monitoring

Monitoring Degree of Blockade

X. Should patients receiving an NMBA by continuous infusion be monitored using PNS with assessment of the train of four (TOF) response, rather than using clinical assessment alone?

Recommendation: The Task Force suggests against the use of PNS with TOF alone for monitoring the depth of neuromuscular blockade in patients on continuous infusion of NMBAs (*weak recommendation, very low quality of evidence*; refer to Table 3 in the original guideline documentation for the evidence profile).

The Task Force suggests that PNS with TOF monitoring may be a useful tool for monitoring the depth of neuromuscular blockade but only if it is incorporated into a more inclusive assessment of the patient that includes clinical assessment (*weak recommendation, very low quality evidence*).

XI. Should patients receiving continuous infusions of an NMBA receive physiotherapy to improve mortality, quality of life, or exercise capacity?

Recommendation: The Task Force suggests that patients receiving a continuous infusion of NMBA receive a structured regimen of physiotherapy (*weak recommendation, very low quality of evidence*; refer to Table 4 in the original guideline document for the evidence profile).

XII. Should patients receiving an NMBA by continuous infusion have their eyes lubricated and covered to prevent corneal abrasions?

Recommendation: The Task Force recommends scheduled eye care that includes lubricating drops or gel and eyelid closure for patients receiving continuous infusions of NMBAs (*strong recommendation, low quality of evidence*; refer to Table 5 in the original guideline document for the evidence profile).

XIII. Do patients receiving sustained NMBA infusions require special nutritional considerations?

Recommendation: The Task Force makes no recommendation regarding nutritional requirements specific to patients receiving infusions of NMBAs (*insufficient evidence*).

Adverse Events

Safeguards

XIV. In patients receiving NMBAs, should additional safeguards be in place to avoid unplanned extubation (UE)?

Recommendation: The Task Force recommends that clinicians at the bedside implement measures to attenuate the risk of UE in patients receiving NMBAs (*good practice statement*).

XV. In critically ill patients receiving NMBAs, has a specific target for blood glucose level been shown to decrease the risk of prolonged weakness?

Recommendation: The Task Force suggests that clinicians target a blood glucose level of less than 180 mg/dL in patients receiving NMBAs (*weak recommendation, low quality of evidence*; refer to Table 6 in the original guideline document for the evidence profile).

Special Populations and End-of-Life Issues

Patients with Myasthenia Gravis

XVI. In critically ill patients with myasthenic syndromes, are there special dosing considerations when administering NMBAs?

Recommendation: The Task Force recommends that a reduced dose of an NMBA be used for patients with myasthenia gravis and that the dose should be based on PNS with TOF monitoring (*good practice statement*).

XVII. Is there a preferred monitoring approach for patients with myasthenia gravis who are receiving NMBAs?

Recommendation: The Task Force makes no recommendation on which muscle group should be monitored in patients with myasthenia gravis undergoing treatment with NMBAs (*insufficient evidence*).

Obese Patients

XVIII. In critically ill obese patients (body mass index ≥ 30 kg/m²), should actual body weight, rather than other measures of weight, be used to calculate the dose of NMBAs?

Recommendation: The Task Force suggests that clinicians not use actual body weight and instead use a consistent weight (ideal body weight or adjusted body weight) when calculating NMBA doses for obese patients (*weak recommendation, low quality of evidence*).

The Task Force makes no recommendation concerning the use of one measure of consistent weight over another when calculating NMBA doses in obese patients (*insufficient evidence*).

Pregnant Patients

XIX. Can continuous NMBA infusions be used in intubated and mechanically ventilated patients who are pregnant and have an indication for the administration of an NMBA?

Response: The Task Force makes no recommendation on the use of NMBAs in pregnant patients (*insufficient evidence*).

Brain Death

XX. Can clinicians determine brain death in patients receiving NMBAs?

Recommendation: The Task Force recommends that NMBAs be discontinued prior to the clinical determination of brain death (*good practice statement*).

End of Life

XXI. In patients receiving NMBAs, should the drugs be discontinued at the end of life or when life support is withdrawn?

Recommendation: The Task Force suggests that NMBAs be discontinued at the end of life or when life support is withdrawn (*weak recommendation, very low quality of evidence*).

Definitions

Quality of Evidence

High	Further research is very unlikely to change confidence in the estimate of effect.
Moderate	Further research is likely to have an important impact on confidence in the estimate of effect and may change the estimate.
Low	Further research is very likely to have an important impact on confidence in the estimate of effect and is likely to change the estimate.
Very low	Any estimate of effect is very uncertain

Strength of Recommendation

The overall strength of a recommendation was determined by the sum of the quality of evidence, the outcomes studied and their relative importance to patients, the balance between desirable and undesirable effects, the cost, and the feasibility of implementation of the intervention for each individual question. Based on these factors, recommendations were classified as strong or weak. The Task Force used the phrasing "we recommend" for strong recommendations and "we suggest" for weak recommendations. Throughout the guideline-development process, the Task Force emphasized patient safety and considered this factor in the recommendation for each intervention. If the risk associated with an intervention limited the potential for benefit, or if the evidence for benefit was not strong enough to accept the potential risks, then the recommendation was changed to "weak." It is also important to mention that individual patient or intensive care unit (ICU) circumstances may influence the applicability of a specific recommendation and that even strong recommendations do not necessarily represent standards of care, depending on resources, culture, or individual clinical situations.

In general, if other factors are equal, the higher the quality of the supporting evidence, the more likely it is for the recommendation to be strong. Conversely, if the quality of the evidence is low or very low, a weak recommendation is more likely. Strong recommendations based on low or very low quality evidence are uncommon. There were some clinical questions that the Task Force members thought deserved strong recommendations despite limited evidence and the likelihood existed to support them (e.g., patients receiving NMBAs should have analgesics and anxiolytics administered). In situations such as this when no clear alternative exists (e.g., not giving analgesics, anxiolytics, or both) and there was consensus among the Task Force members, a strong recommendation was offered with the justification of a "good practice statement" without discrete assessment of the quality of evidence. Clinical questions that lacked adequate evidence to address relevant outcomes of interest and for which the Task Force felt too much uncertainty existed to offer recommendations were clearly indicated with "no recommendation."

Clinical Algorithm(s)

None provided

Scope

Disease/Condition(s)

Conditions for which neuromuscular-blocking agents (NMBAs) may be indicated, including:

- Conditions requiring mechanical ventilation (e.g., acute respiratory distress syndrome [ARDS], status asthmaticus)
- Shivering associated with therapeutic hypothermia
- Acute brain injury and elevated intracranial pressure (ICP)

Guideline Category

Evaluation

Management

Treatment

Clinical Specialty

Anesthesiology

Critical Care

Neurology

Nursing

Pulmonary Medicine

Surgery

Intended Users

Advanced Practice Nurses

Nurses

Physician Assistants

Physicians

Guideline Objective(s)

- To update the 2002 version of "Clinical practice guidelines for sustained neuromuscular blockade in the adult critically ill patient"
- To incorporate new data on the basic science and clinical use of neuromuscular-blocking agents (NMBAs) in the intensive care unit (ICU)

Target Population

- Adults who are patients in medical and surgical intensive care units (ICUs)
- Special populations with critical illnesses being treated with neuromuscular blocking agents (NMBAs), including patients with myasthenia gravis, obese patients, pregnant patients, and patients with suspected brain death or who are at the end of life

Note: Data on the use of NMBAs in critically ill neonates, infants, children, and adolescents was not addressed in this document, although, in a few circumstances, the Task Force has reviewed the results of clinical trials in which NMBAs were studied in pediatric patients if the results of those trials were applicable to adult patients.

Interventions and Practices Considered

1. Use of neuromuscular blocking agents (NMBAs), including route of administration
2. Monitoring degree of neuromuscular blockade with peripheral nerve stimulation (PNS) (if used) and assessment of other clinical findings (e.g., triggering of the ventilator and degree of shivering)
3. Use of a protocol that includes guidance on NMBA administration in patients undergoing therapeutic hypothermia
4. Use of sedative and analgesic drugs prior to initiating neuromuscular blockade
5. Physiotherapy for patients receiving continuous infusions of NMBA
6. Scheduled eye care that includes lubricating drops or gel and eyelid closure for patients receiving continuous infusions of NMBA
7. Measures to attenuate the risk of unplanned extubation
8. Targeting a blood glucose level of less than 180 mg/dL in patients receiving NMBAs
9. NMBA dosing considerations in special populations

Note: The following were considered but specifically not recommended or no recommendation could be made: use of NMBAs in patients with acute brain injury and raised intracranial pressure (ICP), routine use of NMBAs for patients undergoing therapeutic hypothermia

following cardiac arrest, use of PNS to monitor degree of block in patients undergoing therapeutic hypothermia, use of neuromuscular blockade to improve accuracy of intravascular-volume assessment in mechanically ventilated patients, use of electroencephalogram-derived parameters as a measure of sedation during continuous administration of NMBAs, monitoring depth of neuromuscular blockade using PNS with assessment of the train of four (TOF) response alone, special nutritional requirements.

Major Outcomes Considered

- 28-day, 90-day, 1-year, intensive care unit (ICU), or hospital mortality
- Barotrauma (assessed with new pneumothorax, pneumomediastinum, subcutaneous emphysema, or pneumatocele)
- ICU-acquired weakness (assessed with Medical Research Council scale)
- Duration of mechanical ventilation
- Paralysis recovery time
- Mean total paralysis time
- Mean paralytic dose
- Quality of life
- ICU length of stay
- 6-minute walk distance at hospital discharge
- Corneal abrasions
- Clinically significant weakness
- Hypoglycemia
- Adverse effects and complications of neuromuscular-blocking agents (NMBAs)

Methodology

Methods Used to Collect/Select the Evidence

Hand-searches of Published Literature (Primary Sources)

Hand-searches of Published Literature (Secondary Sources)

Searches of Electronic Databases

Description of Methods Used to Collect/Select the Evidence

Relevant literature was compiled from databases (MedLINE, OVID, Clinicaltrials.gov, CINAHL, Cochrane Central Database, and Medwatch), search engines (PubMed and Google Scholar), reference lists from retrieved publications, and the expertise of the authors. Searches were conducted in November 2012 and included the timeframe of 2001 to November 22, 2012 (to capture literature published since the previous guidelines were created) using the following terms: *neuromuscular blocking agents, neuromuscular blockers, cisatracurium, atracurium, rocuronium, vecuronium, pancuronium, succinylcholine, and sugammadex*, each alone and in combination with *sedation, analgesia, monitoring, electroencephalogram (EEG), Bispectral Index (BIS), shock, oxygen delivery, oxygen consumption, pregnancy, kidney failure, acute kidney injury, and intensive care unit*.

Studies involving pediatric patients, operating room patients, or outpatients, as well as studies published prior to the year 2000 were excluded.

Where no data from ICU studies existed to answer a specific question, task force members used the results of studies conducted in the operating room to guide the recommendation, acknowledging the potential decrease in quality of evidence due to indirectness. Randomized controlled trials (RCTs) were preferentially used to formulate evidence summaries. However, if adequate evidence for a specific outcome was not present, Task Force members used the best available evidence, including observational studies, to support recommendations.

Number of Source Documents

A total of 369 studies were identified, and 167 studies were included in the evidence base.

Methods Used to Assess the Quality and Strength of the Evidence

Weighting According to a Rating Scheme (Scheme Given)

Rating Scheme for the Strength of the Evidence

Quality of Evidence

High	Further research is very unlikely to change confidence in the estimate of effect.
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Very low	Any estimate of effect is very uncertain

Methods Used to Analyze the Evidence

Meta-Analysis

Systematic Review with Evidence Tables

Description of the Methods Used to Analyze the Evidence

The Task Force used RevMan2 software to perform pooled analysis of data when appropriate. Published results of clinical trials were used for analysis; abstracts and unpublished studies were excluded. The Task Force used the Grading of Recommendations Assessment, Development and Evaluation (GRADE) system to rate the quality of evidence and strength of the recommendation for each clinical practice question. The Task Force selected outcomes of interest for each question based on GRADE methodology. The GRADE system classifies the quality of the aggregate body of evidence for each question and for each outcome as high, moderate, low, or very low (see the "Rating Scheme for the Strength of the Evidence" field).

The evidence was evaluated using the following criteria: 1) study design and rigor of its execution (i.e., individual study risk of bias), 2) the extent to which the evidence could be applied to patients of interest (i.e., directness) 3) the consistency of results, 4) the analysis of the results (i.e., precision), and 5) whether there was a likelihood of publication bias. The following three factors, if present, lead to potential upgrading of the quality of evidence: 1) a strong or very strong association between an intervention and the observation of interest, 2) a highly statistically significant relationship between dose and effect, and 3) a plausible confounding variable that could explain a reduced effect or could explain an effect if one was not anticipated.

Methods Used to Formulate the Recommendations

Expert Consensus

Description of Methods Used to Formulate the Recommendations

The Guideline Task Force comprised clinicians from North America who are members of the Society of Critical Care Medicine and who have a specific interest in the topic and the guideline process. The Task Force also included a clinician/health-research methodologist from McMaster University who has expertise in evidence synthesis and the Grading of Recommendations Assessment, Development and Evaluation (GRADE) guideline-development process and a medical writer/editor with extensive experience in conducting literature searches. Task Force members developed a list of clinical questions regarding the use of neuromuscular-blocking agents (NMBAs) in critically ill adults in the intensive care unit (ICU) and grouped these questions into five categories: indications for and management of the use of NMBAs; monitoring of NMBAs and sedation; nursing management of the patient receiving an NMBA; adverse events associated with the use of NMBAs in the ICU; and special considerations on the use of NMBAs in specific patient populations. Task Force members were assigned to address each of these categories.

The overall strength of a recommendation was determined by the sum of the quality of evidence, the outcomes studied and their relative importance to patients, the balance between desirable and undesirable effects, the cost, and the feasibility of implementation of the intervention for each individual question. Based on these factors, recommendations were classified as strong or weak (see the "Rating Scheme for the Strength of the Recommendations" field).

Subgroup members wrote the introduction and background for each of the five categories and the recommendations for each of the clinical questions, along with the associated rationale and evidence summary. Evidence profiles were used to present pooled analysis whenever possible. The entire Task Force subsequently reviewed each of the categories and questions. Members' suggestions for improvement and comments were taken into account by each of the subgroups, who were then provided the opportunity to change their recommendations before the entire Task Force subsequently met and evaluated each statement. The wording of individual recommendations, including strength of the recommendations and the quality of evidence upon which the recommendations were based, were agreed upon through consensus of Task Force members after discussing the relevant factors described above. Once the recommendations were compiled, each member again reviewed the guideline document and provided input until consensus was achieved on each of the questions of interest.

Rating Scheme for the Strength of the Recommendations

Strength of Recommendation

The overall strength of a recommendation was determined by the sum of the quality of evidence, the outcomes studied and their relative importance to patients, the balance between desirable and undesirable effects, the cost, and the feasibility of implementation of the intervention for each individual question. Based on these factors, recommendations were classified as strong or weak. The Task Force used the phrasing "we recommend" for strong recommendations and "we suggest" for weak recommendations. Throughout the guideline-development process, the Task Force emphasized patient safety and considered this factor in the recommendation for each intervention. If the risk associated with an intervention limited the potential for benefit, or if the evidence for benefit was not strong enough to accept the potential risks, then the recommendation was changed to "weak." It is also important to mention that individual patient or intensive care unit (ICU) circumstances may influence the applicability of a specific recommendation and that even strong recommendations do not necessarily represent standards of care, depending on resources, culture, or individual clinical situations.

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statement" without discrete assessment of the quality of evidence. Clinical questions that lacked adequate evidence to address relevant outcomes of interest and for which the Task Force felt too much uncertainty existed to offer recommendations were clearly indicated with "no recommendation."

Cost Analysis

A cost analysis was not performed and published cost analyses were not reviewed.

Method of Guideline Validation

External Peer Review

Internal Peer Review

Description of Method of Guideline Validation

External peer review was provided through the Board of Regents of the American College of Critical Care Medicine, the Council of the Society of Critical Care Medicine, the Board of Directors of the American Society of Health-System Pharmacists, and the editorial board of *Critical Care Medicine*.

Evidence Supporting the Recommendations

Type of Evidence Supporting the Recommendations

The type of supporting evidence identified and graded for each recommendation (see the "Major Recommendations" field).

Benefits/Harms of Implementing the Guideline Recommendations

Potential Benefits

- Neuromuscular blockade prevents ventilator asynchrony and may therefore decrease, to an extent, airway pressures and lung stress.
- Evidence from case series and clinical experience suggest that neuromuscular blockade can improve oxygenation in the setting of severe refractory hypoxemia (failure to adequately oxygenate with an Fio_2 of 1.0) and improve hemodynamics in the setting of severe dynamic hyperinflation causing hemodynamic compromise.
- In a post hoc analysis of a prospective observational study of 111 patients, the outcome of 18 patients who received an NMBA for a minimum of 24 hours was compared with the outcome of 93 patients who did not receive an NMBA. Those receiving at least 24 hours of NMBA therapy were found to have had a better prognosis at baseline, related to etiology of the cardiac arrest. This group also had improved in-hospital survival (78% vs 41%; $p = 0.004$), even after adjustment for a large number of potential baseline confounders (odds ratio [OR] = 7.23; 95% confidence interval [CI] = 1.56–33).
- The investigators found that early exercise training, even in the sedated subjects, enhanced functional exercise capacity, quality of life, and muscle force at hospital discharge. Shortened length of mechanical ventilation and a decrease in overall ICU costs were found in one study of sedated, mechanically ventilated patients who received physiotherapy early in their ICU stay.

Evidence of the benefits of specific recommendations is discussed in the "Rationale" sections following each recommendation in the original guideline document.

Potential Harms

- Most of the effects of neuromuscular-blocking agents (NMBAs) that occur outside the neuromuscular junction are cardiac in nature and are due to histamine release and ganglionic or muscarinic stimulation manifested by vagolytic actions, ganglionic blockade, or sympathetic stimulation. Although pancuronium and atracurium have the greatest potential to cause adverse cardiac effects, all NMBAs may cause these cardiac effects.
- All NMBAs potentially react with muscarinic receptors, which can lead to adverse effects, most notably cardiac in origin. In addition, activation of muscarinic type 2 (M2) receptors can result in bronchodilation, whereas activation of muscarinic type 3 (M3) receptors can produce the opposite result (i.e., bronchospasm).
- Prolonged continuous infusion of an NMBA in medical ICU patients was an independent risk factor for at least one abnormal result on an electrophysiologic test for critical illness polyneuromyopathy (CIPNM).
- Neuromuscular blockade has been linked to increased risk of ICU-acquired weakness, and this concern is one of the deterrents to its use in patients with ARDS.
- The wide range in prevalence of unplanned extubation (UE) may, in part, be explained by the definition of neuromuscular blockade—if the patient has adequate neuromuscular blockade, UE can only occur when patients are moved by hospital staff; if the patient is inadequately blocked or if emerging from blockade after discontinuation of an NMBA, the patient may be able to self-extubate.
- Patients with myasthenia gravis who are treated with cholinesterase inhibitors express a reduced plasma cholinesterase activity and are at risk for experiencing prolonged neuromuscular blockade due to a prolonged inactivation of succinylcholine. Furthermore, pyridostigmine inhibits the metabolism of mivacurium and, therefore, delays recovery from this NMBA.

Evidence of the potential harms of specific recommendations is discussed further in the "Rationale" sections following each recommendation in the original guideline document.

Contraindications

Contraindications

- Most clinicians avoid pancuronium in patients with coronary artery disease because of the risk of tachycardia-induced myocardial ischemia, ventricular ectopy, and cardiovascular collapse.
- In the intensive care unit (ICU) where longer-term use may be encountered, the use of pregnancy category C drugs should be avoided because category B drugs are available. Similar to succinylcholine, pancuronium, atracurium, and vecuronium all cross the placenta and are pregnancy class C; their use should be avoided for long-term infusion, especially in the first trimester.

Qualifying Statements

Qualifying Statements

- The recommendations are not absolute requirements, and therapy should be tailored to individual patients taking into account patients' values or preferences, site or specific clinician expertise, and equipment availability in a particular intensive care unit (ICU). The use of neuromuscular blocking agents (NMBAs) requires an appropriate protocol that includes, but is not limited to, management of

mechanical ventilation, analgesia, sedation, nursing care, and point-of-care equipment to monitor the degree of neuromuscular blockade. It is possible that individual recommendations based on evidence from a specific patient population may not be generalizable to a larger critical care population. The Task Force has factored these considerations into their recommendations and have described important subgroup considerations when deemed appropriate. The release of data from ongoing studies and from future research trials may stimulate the Guidelines Update Committee of the American College of Critical Care Medicine to revise these clinical practice guidelines, but, until such time, guideline application by clinicians should always be modified based on new evidence, as it becomes available.

- This document incorporates the best evidence available at the time it was written. As with any guidelines, these recommendations, suggestions, and good practice statements, and their associated strength of evidence should be implemented based upon specific patient factors, clinician experience, and institutional resources and are not intended to be used for all patients in all circumstances. As new agents become available or existing agents are used in new ways, and evidence in support of these changes becomes available, the Society of Critical Care Medicine is committed to updating these guidelines.

Implementation of the Guideline

Description of Implementation Strategy

An implementation strategy was not provided.

Implementation Tools

Mobile Device Resources

Resources

For information about availability, see the *Availability of Companion Documents* and *Patient Resources* fields below.

Institute of Medicine (IOM) National Healthcare Quality Report Categories

IOM Care Need

End of Life Care

Getting Better

Living with Illness

IOM Domain

Effectiveness

Safety

Identifying Information and Availability

Bibliographic Source(s)

Murray MJ, DeBlock H, Erstad B, Gray A, Jacobi J, Jordan C, McGee W, McManus C, Meade M, Nix S, Patterson A, Sands MK, Pino R, Tescher A, Arbour R, Rochweg B, Murray CF, Mehta S. Clinical practice guidelines for sustained neuromuscular blockade in the adult critically ill patient. Crit Care Med. 2016 Nov;44(11):2079-103. [230 references] [PubMed](#)

Adaptation

Not applicable: The guideline was not adapted from another source.

Date Released

2016 Nov

Guideline Developer(s)

American Society of Health-System Pharmacists - Professional Association

Society of Critical Care Medicine - Professional Association

Source(s) of Funding

This activity was funded by the Society for Critical Care Medicine, and no industry support was provided.

Guideline Committee

Guideline Task Force

Composition of Group That Authored the Guideline

Guideline Task Force Members: Michael J. Murray, Geisinger Medical Center, Danville, PA; Heidi DeBlock, Albany Medical Center, Albany, NY; Brian Erstad, University of Arizona College of Pharmacy, Tucson, AZ; Anthony Gray, Clinic Medical Center, Burlington, MA; Judi Jacobi, Indiana University, Indiana, IN; Che Jordan, Grand Strand Medical Center, Myrtle Beach, SC; William McGee, Baystate Medical Center, Springfield, MA; Claire McManus, Saint Elizabeth's Medical Center, Boston, MA; Maureen Meade, University of Toronto, Toronto, Canada; Sean Nix, Riverside Medical Group, Yorktown, VA; Andrew Patterson, University of Nebraska Medical Center, Omaha, NE; M. Karen Sands, Novant Health, Clemmons, NC; Richard Pino, Massachusetts General Hospital, Boston, MA; Ann Tescher, Mayo Clinic, Rochester, MN; Richard Arbour, Lancaster General Hospital, Lancaster, PA; Bram Rochweg, McMaster University, Hamilton, Ontario, Canada; Catherine Friederich Murray, Medscape, New York, NY; Sangeeta Mehta, University of Toronto, Toronto, Canada

Financial Disclosures/Conflicts of Interest

All conflicts of interest were disclosed annually. No Task Force members reported any conflicts of interest during the preparation of the guidelines.

Dr. Murray disclosed participating in healthcare professional organization activities with ASA (Committee Member) and TAS BOD. Dr. Erstad disclosed non-governmental research funding with Mallinckrodt (Research Grant) and healthcare professional organization activities with the American College of Clinical Pharmacy (Treasurer beginning in October). Dr. Jacobi disclosed family relationships with makers of healthcare products (stockholder) and disclosed healthcare professional organization activities with the American College of Clinical Pharmacy (ACCP) (President). Dr. Jordan disclosed healthcare professional organization activities (ACCP member). Dr. McGee disclosed family relationships with makers of healthcare products (Pfizer), healthcare professional organization activities with AAHPM (policy committee) and CHEST (membership committee). Dr. Nix disclosed other healthcare professional organization activities with the American College of Osteopathic Surgery committees 1 (in-service exam committee). Dr. Patterson disclosed family relationships with makers of healthcare products (he is an employee of the University of Nebraska Medical Center) and disclosed non-governmental research grant funding (Co-PI for a Surviving Sepsis in Resource Limited Environment Grant from European Society of Intensive Care Medicine and Hellman Foundation). Dr. Sands disclosed family relationships with makers of healthcare products, for-profit of healthcare services/products, and with providers of healthcare services (consultant/speaker bureau for Hospira, HillRom, and she is owner of Critical Care Learning Curves business focused on critical care continuing education) and disclosed other healthcare professional organization activities (active member of Old Salem AACN and National Member as well). Dr. Pino disclosed family relationships with makers of healthcare products (spouse employed by Genentech). Dr. Rochweg disclosed healthcare professional organization activities (Guideline methodologist for ATS, Canadian Blood services, American Hematology Society). Dr. Friederich Murray disclosed healthcare professional organization activities with the Hypersomnia Foundation (with providers of healthcare services). Dr. Mehta disclosed healthcare professional organization activities (Guideline committee membership ATS ACCP liberation from Mechanical Ventilation). The remaining authors have disclosed that they do not have any potential conflicts of interest.

Guideline Status

This is the current release of the guideline.

This guideline updates previous versions: Clinical practice guidelines for sustained neuromuscular blockade in the adult critically ill patient. Am J Health Syst Pharm. 2002 Jan 15;59(2):179-95. [78 references]

Neuromuscular Blockade Task Force. Clinical practice guidelines for sustained neuromuscular blockade in the adult critically ill patient. Crit Care Med. 2002;30(1):142-56. [78 references]

This guideline meets NGC's 2013 (revised) inclusion criteria.

Guideline Availability

Available from the [Critical Care Medicine Journal Web site](#) .

Availability of Companion Documents

A podcast is available from the [Society of Critical Care Medicine \(SCCM\) Web site](#) .

A guidelines app is available from the [SCCM Web site](#) .

Patient Resources

None available

NGC Status

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